Investigation 5

Patterns With Exponents

As you explored exponential relationships in previous investigations, you made tables of exponential growth. This table shows some values for $y = 2^x$. The y-values are given in both exponential and standard form.

x	y
1	2^1 or 2
2	2^2 or 4
3	2^3 or 8
4	2^4 or 16
5	2^5 or 32
6	2^6 or 64
7	2^7 or 128
8	2^8 or 256

There are many interesting patterns in the table.

Getting Ready for Problem 5.1

- Look at the column of y-values in the table. What pattern do you see in how the ones digits of the standard forms change?
- Can you predict the ones digit for 2^{15}? What about 2^{50}?
- What other patterns do you see in the table?
- Find an x-value and values for the missing digits that will make this a true number sentence.

  $2^x = \_\_\_\_\_ 6$

5.1 Predicting the Ones Digit

The values of a^x for a given number a are called *powers of a*. You just looked at powers of 2. In this problem, you will explore patterns in other powers.

Problem 5.1 Predicting the Ones Digit

A. Copy and complete this table.

Powers Table

x	1^x	2^x	3^x	4^x	5^x	6^x	7^x	8^x	9^x	10^x
1	1	2								
2	1	4								
3	1	8								
4	1	16								
5	1	32								
6	1	64								
7	1	128								
8	1	256								
Ones Digits of the Powers	1	2, 4, 8, 6								

B. Describe patterns you see in the ones digits of the powers.

C. Predict the ones digit in the standard form of each number.

1. 4^{12} **2.** 9^{20} **3.** 3^{17} **4.** 5^{100} **5.** 10^{500}

D. Predict the ones digit in the standard form of each number.

1. 31^{10} **2.** 12^{10} **3.** 17^{21} **4.** 29^{10}

E. Find the value of a that makes each number sentence true.

1. $a^{12} = 531,441$ **2.** $a^9 = 387,420,489$ **3.** $a^6 = 11,390,625$

F. Find a value for a and values for the missing digits to make each number sentence true. Explain your reasoning.

1. $a^7 = \_\_\_\_\_3$ **2.** $a^8 = \_\_\_\_\_1$

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5.2 Operating With Exponents

In the last problem, you explored patterns in the values of a^x for different values of a. You used the patterns you discovered to make predictions. For example, you predicted the ones digit in the standard form of 4^{12}. In this problem, you will look at other interesting patterns that lead to some important properties of exponents.

Getting Ready for Problem 5.2

- Federico noticed that 16 appears twice in the powers table. It is in the column for 2^x, for $x = 4$. It is also in the column for 4^x, for $x = 2$. He said this means that $2^4 = 4^2$. Write 2^4 as a product of 2's. Then, show that the product is equal to 4^2.
- Are there other numbers that appear more than once in the table? If so, write equations to show the equivalent exponential forms of the numbers.